DISENTANGLING X-RAY EMISSION PROCESSES IN VELA-LIKE PULSARS

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Progress Report

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This grant is to support analysis of data from the X-ray Multi-mirror Mission (XMM). Specifically, we have been awarded time to observe two young neutron stars, B1823-13 and B1046-58, whose X-ray emission is expected to be a complicated combination of emission from an associated supernova remnant, from a wind-powered synchrotron nebula, from magnetospheric pulsations, and from the surface of the neutron star itself. It is only with XMM's unique combination of spectral, temporal and angular resolution that all these different processes can be separated and studied.

Observations for our first target, B1823-13, were carried out successfully in October 2001, and we received the data in December 2001. In the last six months, the PI, Bryan Gaensler, has been analyzing and interpreting these observations. Progress was initially slow, as this was our team's first experience at analyzing data from this new mission. However, after sorting out various software problems and pipeline uncertainties, we are now close to completion of our analysis for this source.

This work has demonstrated that there is an extended source of emission associated with B1823-13, approximately 4 arcmin across. We decompose this emission into two parts: a condensed core centered on the neutron star, surrounded by a fainter diffuse nebula. Our analysis demonstrates the core to be extended, with a power law spectrum of photon index 1.5. A timing analysis at the pulsar position shows no evidence of pulsed emission. For the diffuse component, spectral analysis shows equally good fits to a power law of photon index 2, and a thermal plasma of temperature 5 keV.

We interpret these data as follows. The unpulsed extended non-thermal nature of the central core argues that this emission corresponds to synchrotron emission from a nebula powered by the pulsar. The temperature of the diffuse component is too high to be interpreted as thermal emission; we rather argue that this extended component is non-thermal emission from a surrounding supernova remnant shell, as has been recently seen toward G21.5-0.9.

We are now in the process of writing up these results, with the intention of submitting a paper to The Astrophysical Journal in the next few months. Dr Gaensler presented preliminary results on this work as part of a review talk on pulsar winds at the American Physical Society annual meeting held in Albuquerque in April 2002. Dr Gaensler also intends to present this result at two pending conferences: in a talk on X-ray observations of pulsars at the meeting "Winds, Bubbles and Explosions" to be held in Patzcuaro, MMexico, in September 2002, and as a poster at the 34th COSPAR Scientific Assembly in Houston TX in October 2002.

The main expense from this grant to date has been the purchase of a high-speed Linux PC, which has been used for data analysis and associated simulations. Future expenditures are anticipated relating to the conferences described above.